Mitigating Traffic-Related Particle Pollution

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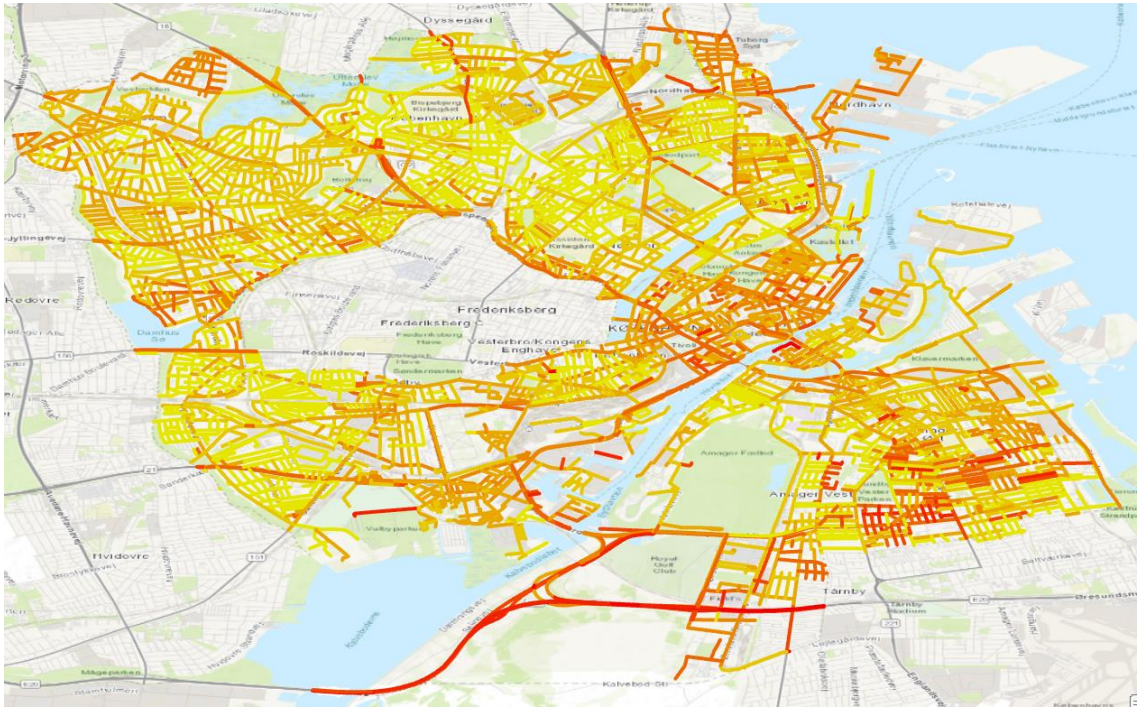
AGENDA 21 · FOR ET BÆREDYGTIGT KBH

Particle Pollution in Copenhagen



Particle Pollution: Sources and Classification

Vehicle Emissions

Diesel

Petrol

(*combustion*)

Energy Production

Coal

Biomass

(*combustion*)

Abrasion Surfaces

Tires

Brakes

Roadware

Construction Sites

Machinery

Earthworks

Demolition

Particle Pollution: Sources and Classification

PARTICLE TYPE	ABBREVIATION	DIAMETER (μm)	METRIC
coarse particles	PM_{10}	2.5 - 10	$\mu g/m^3$
fine particles	$PM_{2.5}$	< 2.5	$\mu g/m^3$
ultrafine particles	$PM_{0.1}$	< 0.1	$number/m^3$
nanoparticles	$PM_{0.02}$	< 0.02	$number/m^3$

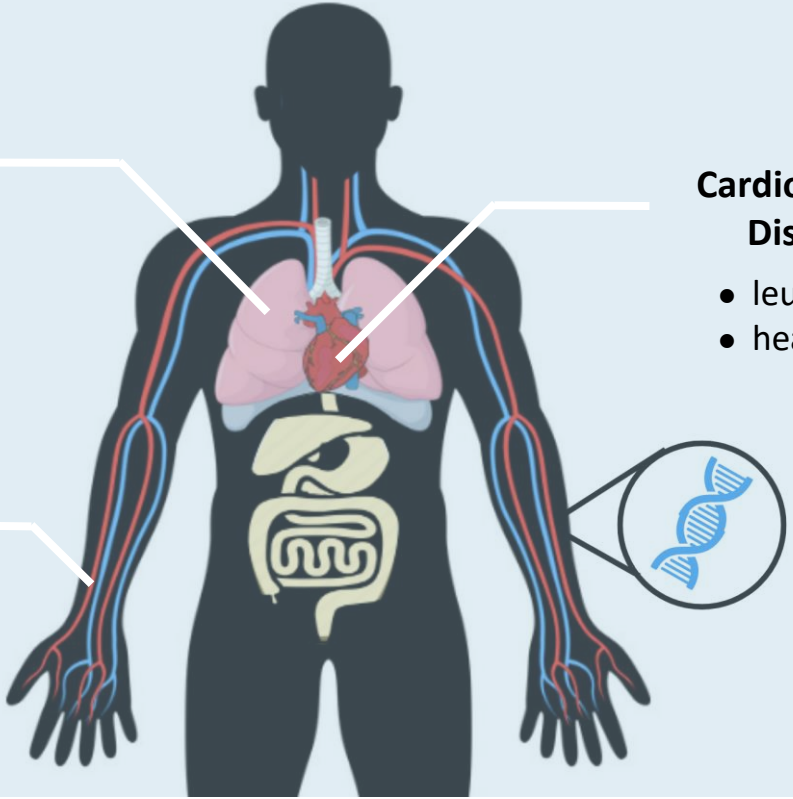
Particle pollution has many serious adverse health effects

Respiratory Diseases

- asthma
- bronchitis
- COPD

Cardiovascular Diseases

- leukemia
- heart failure



Nervous System Damage

- Parkinson's disease
- Alzheimer's disease

Genetic Damage

- cell mutations
- cancer

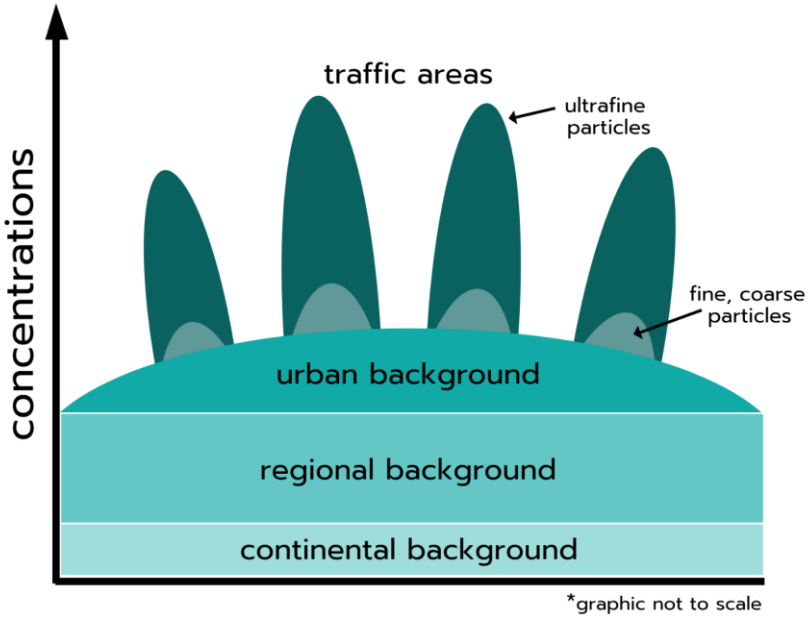
PM concentration limits hide the urgency of reducing PM pollution in Copenhagen, especially UFPs

PARTICLE TYPE		EU Limit ($\mu g/m^3$)	WHO Limit ($\mu g/m^3$)	HC Andersens Blvd. ($\mu g/m^3$)
coarse particles	PM_{10}	40	20	25
fine particles	$PM_{2.5}$	25	10	13
ultrafine particles	$PM_{0.1}$	?	?	13,000 part./cm^3

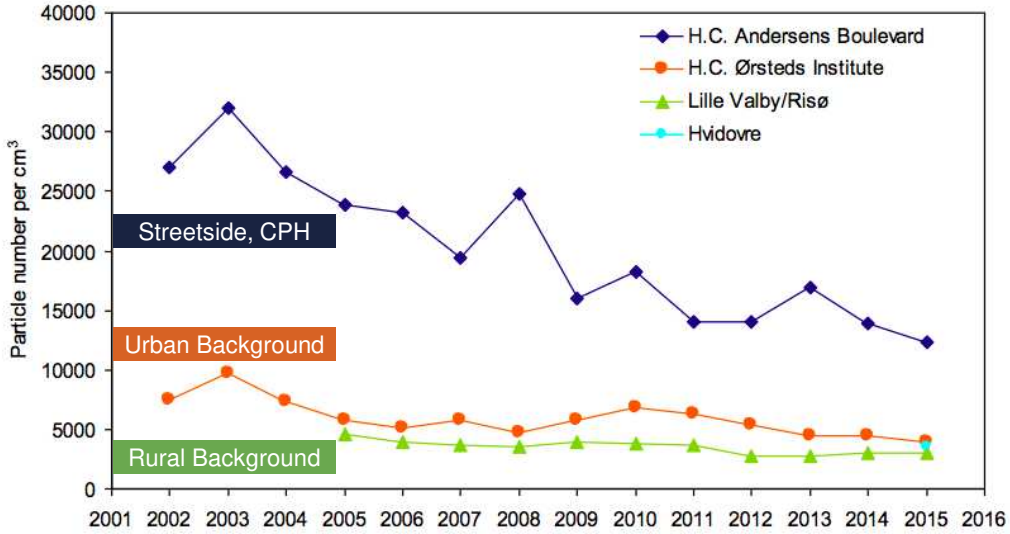
"**4,000 Danes die [prematurely] every year** due to fine particle pollution. That's **7% of all Danish death[s]**... That makes fine particles in outdoor air our **third highest risk factor**"

— Kåre Press-Kristensen

Traffic is the most significant contributor to dangerous levels of Copenhagen's roadside UFP pollution



Particle Number (UFP) Concentrations in Denmark



Project Objectives

1 International Study

- Global Efforts
- Existing Trends
- New Strategies

2 Local Investigation

Copenhagen, DK

3 Identifying Solutions

Regulation & Enforcement

Effective Technology

Social Adoption

Project Tasks

LITERATURE REVIEW

- policy
- technology
- practice

KEY INTERVIEWS

- technical
- academic
- political
- public interests
- private interests

DATA COLLECTION

- busy street
- bus stop
- idling taxis

INFORMATION ANALYSIS

- cross-verification
- prioritization
- feasibility

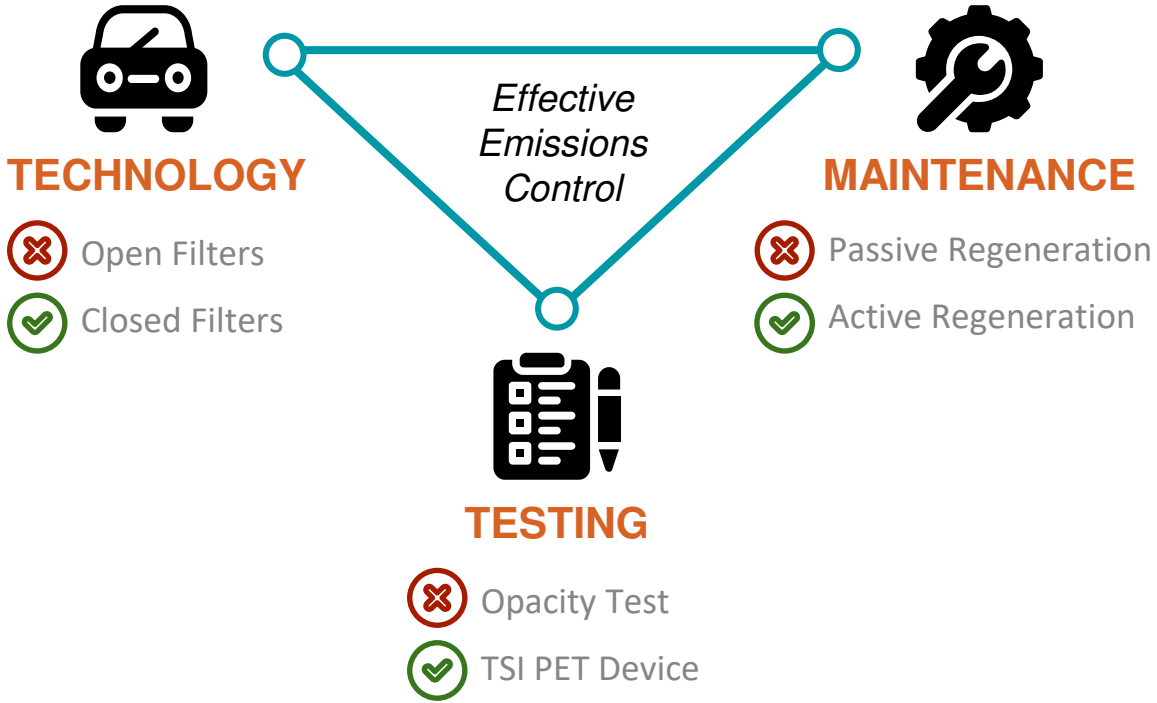
Filter technology & emissions tests of many on-road diesel passenger cars are not effective (pt. 1)

TECHNOLOGY

- Open Filters
- Closed Filters

	Diesel Vehicle	Effective Date Factory/Sale	Particle Mass Limits	Particle Number Limits
Euro 1	Passenger Car	1992/1993	140 mg/km	--
Euro 2	Passenger Car	1996/1997	100 mg/km	--
Euro 3	Passenger Car	2000/2001	50 mg/km	--
	Truck/Bus	2000/2001	100 mg/km	--
Euro 4	Passenger Car	2005/2006	25 mg/km	--
	Truck/Bus	2005/2006	20 mg/km	--
Euro 5	Passenger Car	2009/2010	5 mg/km	6e11 part./km
	Truck/Bus	2009/2010	20 mg/km	--
Euro 6	Passenger Car	2014/2015	5 mg/km	6e11 part./km
	Truck/Bus	2013/2013	10 mg/km	8e11 part./kWh

Filter technology & emissions tests of many on-road diesel passenger cars are not effective (pt. 2)



Movia's public bus fleet contains many diesel buses with outdated, ineffective filter technology

TECHNOLOGY

- ✗ Open Filters
- ✓ Closed Filters

MAINTENANCE

- ✗ Passive Regeneration
- ✓ Active Regeneration

VEHICLE TYPE	TECHNOLOGY SPECIFICATION	# OF BUSES	
Euro 2	CRT	1	*
Euro 3	CRT	73	*
Euro 4	----	96	*
	SCRT Retrofitted to Euro 6	12	
Euro 5	----	93	*
	SCRT Retrofitted to Euro 6	7	
EEV	----	400	*
	SCRT Retrofitted to Euro 6	179	
Euro 6	----	453	
Electric	----	78	
Total		1,392	

CRT = Continuous Regeneration Technology
SCRT = Selective Catalytic Reduction Technology
EEV = "Enhanced Environmentally-Friendly Vehicle"

6% of buses are electric
78 Electric / 1,392 total

50% of diesel buses use old filters
663 buses / 1314 diesel buses

At minimum,

74 buses use passive regeneration filters

Traffic companies often supplement the EU regulated emissions tests with their own procedure

TESTING

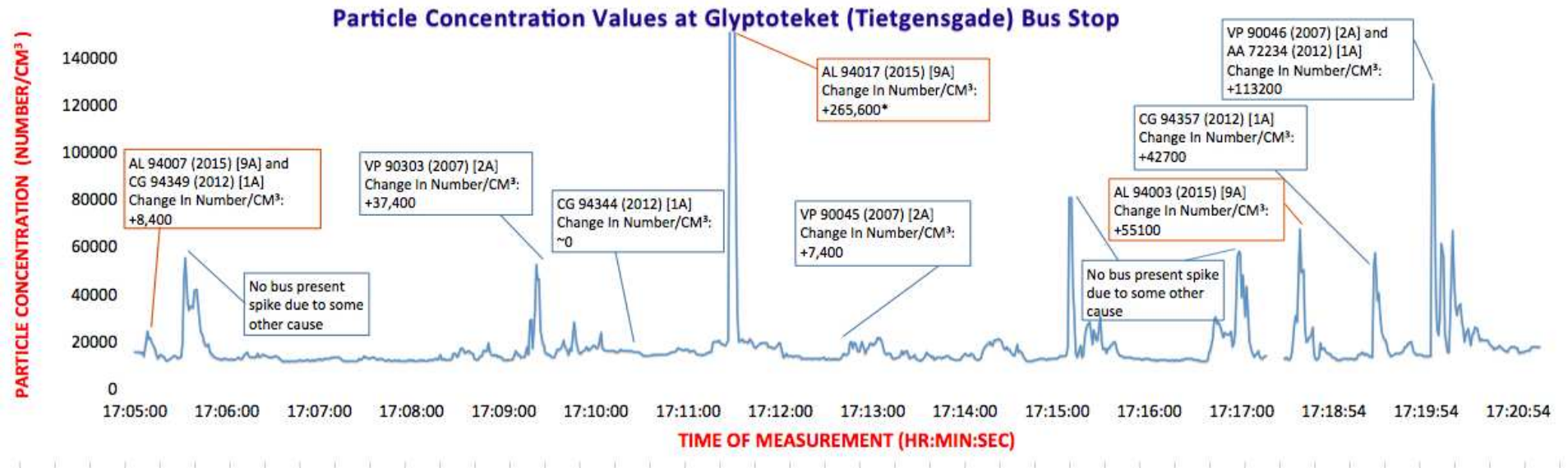
- Opacity Test
- On-Board Diagnostics Test
- Particle Number Count

Opacity

OBD

Miljøsyn

Streetside Data Collection: Public Buses



Streetside Data Collection: Public Buses

Euro Norm	License Plate Number	Particle Count (Number/cm³)
Euro 6	AL 94007	8,400*
	AL 94021	42,900*
	AL 94003	55,100
	AL 94013	208,100
	AL 94017	265,600

*Indicates the measurement was the result of combined emissions (Euro 5 bus also present at bus stop)

Eliminate preventable particle pollution from diesel vehicles during the transition to emissions-free transportation

Long term efforts should support the transition to zero-emission transportation

LIGHT-DUTY
(diesel passenger cars, taxis)

- new car registration tax
- filter tax
- city emissions tax

extend Euro 6 environmental zone to passenger vehicles

HEAVY-DUTY
(diesel buses)

Funding for more electric buses in Movia's fleet

fossil fuel → biofuel → electric

Short term efforts should address the imminent problems with diesel emissions

LIGHT-DUTY
(diesel passenger cars, taxis)

Retrofit vehicles with Euro 6 emissions-equivalent filters

Regulate use of TSI PET emissions test

HEAVY-DUTY
(diesel buses)

Retrofit vehicles with Euro 6 emissions-equivalent filters

Regulate use of P-Trak (UFP) measurement in emissions test

Immediate efforts should engage citizens in the issue while the government passes legislation

Public Awareness Events

Handkerchief Emissions Test

1. Attach white handkerchief or kitchen towel to tailpipe
2. Drive car or rev engine
3. Check towel; if dirty, the filter is malfunctioning and should be brought in for maintenance

Reporting Idling & Malfunctioning Public Buses via Municipality App

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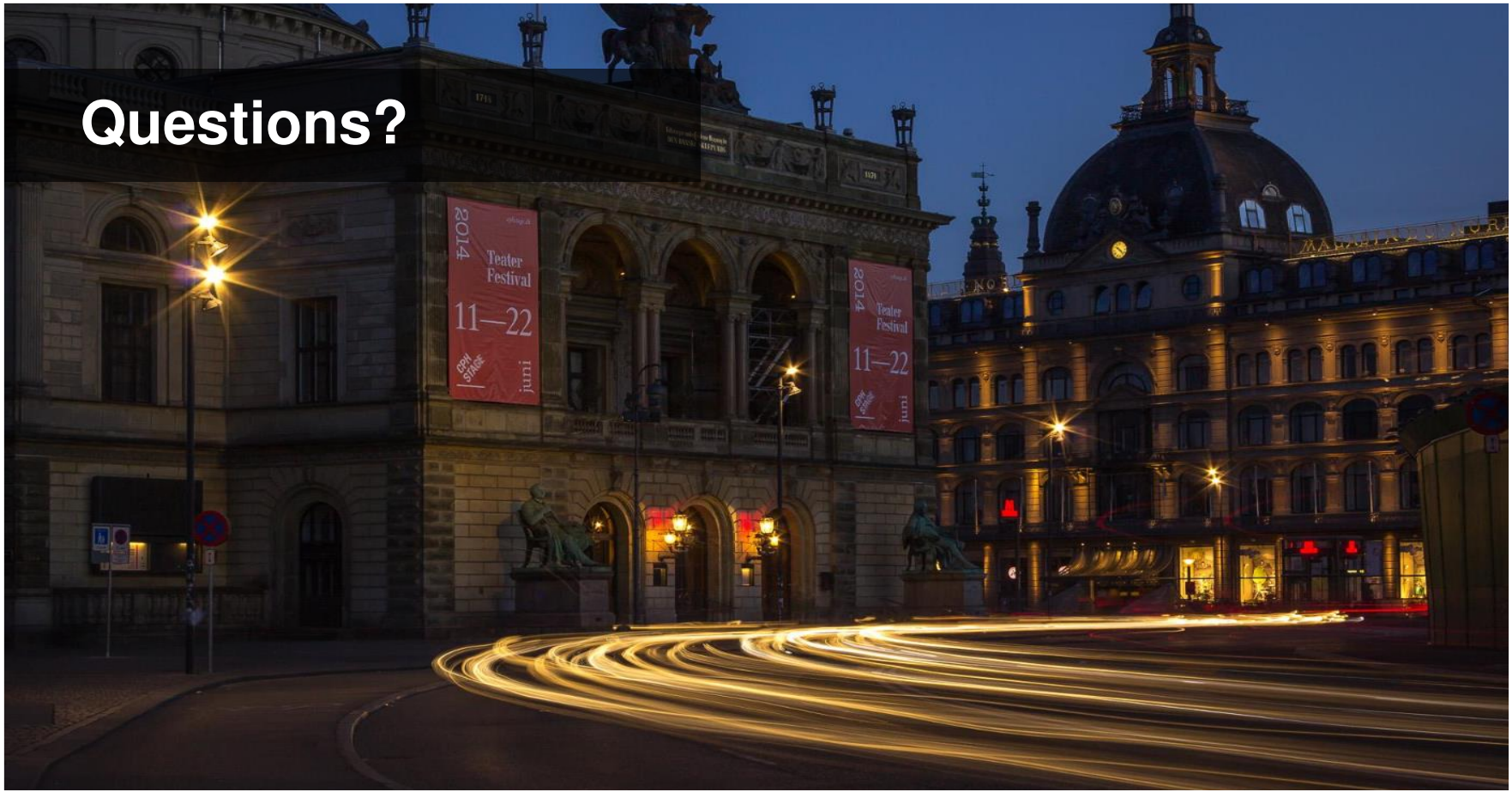
Questions?


2014
Teater
Festival
11—22
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2014
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Recommendations Summary

- **Prioritize shift to emission-free transportation**
  - Discourage diesel car ownership
  - Encourage electric vehicles
- **Enforce tighter regulation on diesel emissions**
  - Retrofit all vehicles with Euro 6 emission-equivalent DPFs
  - Extend environmental zone to all diesel vehicles
- **Standardize adequate emission testing to ensure DPF technology remains functional**
  - TSI PET tests for light-duty diesel vehicles
  - Particle number parameter for heavy-duty diesel vehicle tests